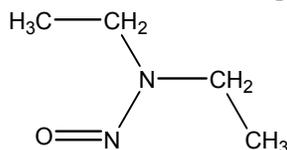


N-NITROSODIETHYLAMINE

CAS No. 55-18-5

First Listed in the *Second Annual Report on Carcinogens*



CARCINOGENICITY

N-Nitrosodiethylamine is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity in experimental animals (IARC 1978, 1982, 1987). When administered in the drinking water, *N*-nitrosodiethylamine induced liver tumors in guinea pigs, rabbits, dogs, and rats, and nasal cavity tumors in rats. When administered in the feed or by gavage, *N*-nitrosodiethylamine induced liver tumors in rats, monkeys, mice, and pigs; kidney tumors in rats; forestomach and lung tumors in mice; and tumors of the esophagus in mice and rats. When applied on the skin, the compound induced nasal cavity tumors in mice and hamsters. When administered by inhalation, *N*-nitrosodiethylamine induced liver tumors in rats, and tumors of the trachea, bronchi, and lungs in hamsters. When administered by subcutaneous injection, the compound increased the incidence of lung tumors in adult and newborn mice, and it induced respiratory tract tumors in Syrian golden hamsters. When administered by subcutaneous or intramuscular injection, *N*-nitrosodiethylamine induced tumors of the forestomach and esophagus in Chinese hamsters, liver tumors in birds, upper respiratory tract tumors in newborn hamsters, and liver and respiratory tract tumors in gerbils, guinea pigs, and hedgehogs. When administered subcutaneously to pregnant mothers, the compound induced pulmonary adenomas and liver, esophagus, and forestomach tumors in mouse offspring; kidney and mammary tumors in rat offspring; and tracheal and other respiratory tract tumors in hamster offspring. When administered by intraperitoneal injection, the compound induced liver tumors in adult and newborn monkeys, mice, rats, and hamsters; lung tumors in mice; and respiratory tract tumors in hamsters. When administered by intravenous injection, *N*-nitrosodiethylamine induced kidney tumors in rats and nasal cavity tumors in gerbils. When administered by intrarectal injection, the compound induced hepatocellular carcinomas in rats. When administered intradermally, *N*-nitrosodiethylamine induced nasal cavity papillomas in hamsters. When administered by gavage followed by subcutaneous injections, the compound induced a large leiomyosarcoma of the liver. When administered by immersion, *N*-nitrosodiethylamine induced liver tumors in fish.

No adequate human studies of the relationship between exposure to *N*-nitrosodiethylamine and human cancer have been reported (IARC 1978, HSDB 2002).

PROPERTIES

N-Nitrosodiethylamine is a volatile, clear yellow oil that is soluble in water, alcohol, ether, other organic solvents, and lipids. The compound is sensitive to light, especially ultraviolet light, and undergoes relatively rapid photolytic degradation. When heated to decomposition, *N*-nitrosodiethylamine emits toxic fumes of nitrogen oxides (IARC 1978, HSDB 2002).

USE

N-Nitrosodiethylamine is used primarily as a research chemical. It is used as a gasoline and lubricant additive, antioxidant, stabilizer in plastics, fiber industry solvent, copolymer softener, and starting material for synthesis of 1,1-diethylhydrazine. It is also used to increase dielectric constants in condensers (IARC 1972, HSDB 2002).

PRODUCTION

Chem Sources (2001) identified 10 U.S. suppliers of *N*-nitrosodiethylamine. Current production data were not available, and there was no evidence that *N*-nitrosodiethylamine is manufactured commercially in the United States (HSDB 2002). The 1979 TSCA Inventory reported two U.S. companies producing 1,000 lb of the compound in 1977, but no import or export data were reported (TSCA 1979).

EXPOSURE

The primary routes of potential human exposure to *N*-nitrosodiethylamine are ingestion, inhalation, and dermal contact. There is some potential for occupational exposure of laboratory, copolymer, lubricant, and pesticide workers. Synthetic cutting fluids, semisynthetic cutting oils, and soluble cutting oils may contain nitrosamine, either as contaminants in amines or as products from reactions between amines and nitrite. Concentrations of nitrosamine have been found in certain synthetic cutting oils at levels ranging from 1 to 1,000 ppm. There are approximately 8 to 12 additives that could be responsible for nitrosamine formation in cutting oils. Approximately 750,000 to 780,000 workers employed by more than 1,000 cutting fluid manufacturing firms are potentially exposed to nitrosamine in cutting oils. In addition, there is potential exposure of an undetermined number of machine shop workers who use these fluids. The general population may possibly be exposed to unknown quantities of *N*-nitrosodiethylamine present in foods, beverages, tobacco smoke, herbicides, pesticides, drinking water, and industrial pollution. Estimates indicate that air, diet, and smoking contribute to potential human exposure at levels of a few μg per day. *N*-Nitrosodiethylamine is present in a variety of foods, including cheeses at concentrations of 0.5 to 30 $\mu\text{g}/\text{kg}$, soybeans at 0.2 $\mu\text{g}/\text{kg}$, soybean oil at 4 $\mu\text{g}/\text{kg}$, various fish at <1 to 147 $\mu\text{g}/\text{kg}$, salt-dried fish at 1.2 to 21 mg/kg, cured meats at up to 40 $\mu\text{g}/\text{kg}$, and alcoholic beverages at 0.1 $\mu\text{g}/\text{kg}$ (IARC 1978). *N*-Nitrosamines such as *N*-nitrosodiethylamine are frequently produced during rubber processing and may be present as contaminants in the final rubber product. Potential exposure depends on the ability of the nitrosamines to migrate from the product into the body. CPSC and FDA reported that nitrosamines have been detected in pacifiers and baby bottle nipples, which could result in potential ingestion of these compounds. *N*-Nitrosodiethylamine has been detected in tobacco smoke condensate at concentrations of 1.0 to 28 ng/cigarette. Up to 8.3 ng/cigarette were found in mainstream smoke and 8 to 73 ng/cigarette were found in sidestream smoke. An analysis of indoor air polluted with tobacco smoke indicated levels of up to 0.2 ng/L of *N*-nitrosodiethylamine (Brunnemann *et al.* 1977). The compound has also been found at a concentration of 10 ng/m³ in the smoking compartment of a train (Brunnemann and Hoffmann 1978).

N-Nitrosodiethylamine is widespread in the environment, but it is rapidly decomposed by sunlight, and thus does not usually persist in ambient air or water illuminated by sunlight (EPA 1979). *N*-Nitrosodiethylamine was detected in the air in Baltimore, MD. The compound has been found in high-nitrate well water for drinking at concentrations of 0.010 $\mu\text{g}/\text{L}$ and in

deionized water at 0.33 to 0.83 µg/L. Wastewater from two chemical plants contained 0.07 and 0.24 µg/L (IARC 1978). Significant levels of *N*-nitroso compounds have been identified in a number of materials, including pesticides, cosmetics, cutting fluids, and fire-resistant hydraulic fluids. The *N*-nitroso compounds found in these products were apparently formed *in situ* during storage or handling as the result of a reaction between amines present in the mixture and inorganic nitrite, which may have been added as a corrosion inhibitor (CHIP 1978).

EPA's Toxic Chemical Release Inventory (TRI) listed three facilities that produced, processed, or otherwise used *N*-nitrosodiethylamine in 1999. Releases to land accounted for 99.6% of the total estimated releases of 7,671 lb (TRI99 2001).

REGULATIONS

EPA regulates *N*-nitrosodiethylamine under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which established a reportable quantity (RQ) of 1 lb. EPA also regulates *N*-nitrosodiethylamine under the Clean Water Act (CWA) with respect to accidental releases of the compound, and under the Resource Conservation and Recovery Act (RCRA) as a constituent of hazardous waste. The Superfund Amendments and Reauthorization Act (SARA) identifies *N*-nitrosodiethylamine as a toxic chemical and subjects it to reporting requirements. Under the Toxic Substances Control Act (TSCA), EPA has prohibited the addition of nitrites to fluids used in metal cutting if they contain triethanolamine salt, tricarboxylic acid, or a tricarboxylic acid intermediate. EPA will issue a Chemical Advisory to warn about the risks of nitrosamine formation. EPA will issue a general rule under TSCA to control nitrosamine formation in metalworking fluids.

An enforcement policy was issued by CPSC announcing that the Commission may take action against pacifiers, containing more than 60 ppb nitrosamine, entering interstate commerce. This project is coordinated with an FDA study of nitrosamine in rubber baby bottle nipples. These studies have detected the presence of specific nitrosamines, including *N*-nitrosodiethylamine, in pacifiers and nipples, and the amounts released into saliva simulant and food. FDA has set a 10-ppb limit on nitrosamines in rubber nipples for baby bottles. An ASTM standard has been developed which sets the level of nitrosamine in pacifiers at 10 ppb for any individual nitrosamine.

OSHA regulates *N*-nitrosodiethylamine under the Hazard Communication Standard and as a chemical hazard in laboratories. Regulations are summarized in Volume II, Table 127.

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